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POSSIBLE DEGREES OF ENIWETOK CLEANUP

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In principle, the extent of the radiological cleanup possibilities for Eniwetok Atoll range between cleanup to no detectable residual radiation and doing nothing. To facilitate making judgments on what is best, only a limited number of options between these limits should be considered. For each option, consideration must be made of the costs -- both financially and in terms of consequent insult to the islands -- and, on the other hand, consideration must be made of the remaining radiological risk to the occupants of the Atoll.

The Armed Forces Radiobiological Research Institute is currently assisting the Defense Nuclear Agency in making estimates of the radiological consequences of the various options. This effort between AFRRI and DNA is intended only to be an adjunct to the complete study being undertaken by the Atomic Energy Commission.

In these different options of cleanup, residual radiological levels result from an interplay between (1) radiological levels that happen to be presented as isodoses in the existing surveys of the Atoll and (2) customary standards used elsewhere for residual radioactivity levels.

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In our first look at the radiological consequences to the Islanders, we shall use the "worst case" assumptions. In the "worst case" outlook, residency is assumed to be dominantly in the most radioactive regions remaining; even this is limited and undesirable space; furthermore, the past diet of local foods is assumed to be continued in this "worst case", even though some of these trees are now virtually extinct on the Atoll. (Although intentions to do otherwise might initially be sincere, political or population pressures in the future could conceivably result in the "worst case" for both residency and diet).

The options being considered involve a two-dimensional matrix. One dimension (Roman Numerals) is residual radioactivity; the other dimension (letters) is living patterns, involving places of occupancy and foods to be eaten.

Options of Residual Radioactivity

I. No Radiological Cleanup.

For the entire population, the plutonium concentration (~1300 pCi/g) of the central band of Yvonne (Runit) is used along with the beta- and gamma-ray exposure (~1mR/hr) at the lips of the Cactus crater on Runit and the Seminole crater on Irene (Bogon).

II. Cleanup Only of Plutonium over ~260 pCi/g.

This involves cleanup of the central band of Yvonne (Runit) and possibly of the buried plutonium at the lip of the Seminole crater on Irene (Bogon). Thus, the remaining high plutonium concentrations of ~260 pCi/g on Belle (Bogombogo) would be used for the entire population, along with the ~ 1mR/hr of beta- and gamma-ray exposure in Option I above.

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III. Cleanup of Beta- and Gamma-Ray Activity to ~131 μR/hr and plutonium to ~200 pCi/g.

The Yvonne (Runit) plutonium cleanup of Option II is involved in this and the following Options. Beta- and gamma-ray areas are cleaned to ≲131 μR/hr (to the "H" isodose contour of the E.G. and G. survey). Thus the remaining high plutonium concentration of ~196 pCi/g, which is on Alice (Bogallua), would be used along with ~131 μR/hr of beta- and gamma-ray exposure for the entire population.

IV. Cleanup of Beta- and Gamma-Ray Activity to ~65 μR/hr and plutonium to ~70 pCi/g.

The beta- and gamma-ray cleanup of Option III would be extended to ≲65 μR/hr (to the "G" contour of E.G. and G.) with the consequence that plutonium concentrations would likely be reduced to ≲70 pCi/g.

V. Cleanup of Beta- and Gamma-Ray Activity to ≲33 μR/hr.

The beta- and gamma-ray cleanup of Options III and IV would be extended to ≲33 μR/hr (to the "F" contour of E.G. and G.) with the consequence that plutonium concentrations would likely be reduced to ≲7 pCi/g as, for example, would remain on Sally (Aomon).

Options of Living Patterns

A. No Restrictions

No restrictions on place of occupancy means, for the "worst case," that the entire population lives where the residual external radioactivity is largest. The food consumption is assumed to be the same as that given by Gustufson[1] for Bikini Atoll; no food supplements nor corrective action on tree cultivation are assumed.

B. No Occupancy Restrictions; Corrective Measures on Pandanus Fruit

As in A, no occupancy restrictions apply. Pandanus trees would always be grown with radioactive soil removed from around them.

[1] P.F. Gustufson, "Radiological Report on Bikini Atoll," U.S. AEC Notes, April 1958 (unpublished; no report number) p. 3

C. Occupancy Only in the South-Eastern Side of the Atoll; Corrective Measures on Pandanus

Islands in the north-western side of the Atoll would be excluded from occupancy; only islands on the south-eastern side would be occupied. The pandanus fruit restriction above applies.

D. Occupancy Only in the South-Eastern Side of the Atoll; All Imported Foods

Occupancy would be like C above. All food would be imported;

The consequent matrix of possible options is attached. The intention is to complete such a matrix with (1) entries of consequent leukemia and cancer rates, (2) entries of insults to islands and operational difficulties, or (3) monetary costs.

Extent of Cleanup Involved

Option II involves minimal insult to the terrain and vegetation now existing. The central part of Yvonne (Runit) presently has little vegetation. The terrain now has a ridge of soil running as a "spine" down the island. This artifact remains from cabling during tests. It can be used for filling the area where plutonium contaminated soil is removed.

Option III to remove the greatest beta- and gamma-ray activity involves little insult to important islands. Removing part of the crater lips is actually a step toward restoration to original conditions. In addition, for some small islands, soil would have to be plowed to bury the top layer containing fallout. This would first involve denuding those parts of these islands of vegetation. Theamounts would be:

96% of the 30 acres of Belle (Bogombogo)
4% of the 291 acres of Janet (Enjebi)
5% of the 54 acres of Pearl (Rujiyoru)

Option ~~IV~~ III is an extention of the denuding and plowing described above. In addition, the important island of Janet (Enjebi) would be significantly affected by denuding of vegetation and then plowing or soil overlay (as required). The amounts, aside from crater lips, would be:

~90%	of the	22	acres	of	Alice (Bogallua)
~100%	"	" 30	"	"	Belle (Bogombogo)
40%	"	" 7	"	"	Clara (Eybbiyae)
15%	"	" 21	"	"	Daisy (Lidilbut)
32%	"	" 46	"	"	Irene (Bogon)
~55%	"	" 291	"	"	Janet (Enjebi)
20%	"	" 54	"	"	Pearl (Rujiyoru)

Options ~~IV and~~ V progressively insult the northern islands by denuding and plowing (or soil overlays).

Radiological Consequences

The purpose of the study based on this matrix of options and elsewhere is to ascertain these radiological consequences, particularly as measured by possible increase in the incidence of cancer and leukemia for the ~$4(10^2)$ Eniwetok People.

One example is what is currently the extreme of possible cancer incidence as projected by Goffman and Tamplin. They project one cancer per 2,000 population per year (after 15 years) for 170 mR/yr. (For case I of the matrix.) The external radiation for the "worst case" of 1mR/hr for the whole population is ~ 50 times greater than this, and so the most pessimistic projection would be 10 cancers per year for the $4(10^2)$ population from this external exposure. (column A of the matrix)

In the "worst case" of unrestricted diet and the projections of Goffman and Tamplin, the incidence of leukemia would similarly be significant. Based on the similarity of strontium-90 in foods for Bikini and Eniwetok and the figures of Gustafson, the internal exposure would also be a factor of 50 over the 170 mR/yr base. Again, 10 cases per year would pessimistically be projected, but this for leukemia from strontium-90 internal exposure (after 15 years).

We emphasize that these Goffman and Tamplin projections are very pessimistic. Other projections are less by an order of magnitude or even orders of magnitude. Nevertheless, in "worst case" analyses of uncontrolled situations, the difficulty of reducing the internal exposure from strontium-90 might well be a limiting factor. In particular, the internal exposure might quickly dominate when attempts are made to reduce the external exposure, and so a compromise of the extent of radiological cleanup might be found to be reasonable.

Matrix of Options (Consequences will be filled in)

Residual Radioactivity \ Living Patterns	A. No Restrictions	B. Live Anywhere; Pandanus Correction	C. Live in S.E.; Pandanus Correction	D. Live in S.E.; Imported Food
I. 1300pCi/g of Pu; 1mR/hr of β+γ				
II. 260pCi/g of Pu; 1mR/hr of β+γ				
III. 196 pCi/g of Pu; 131μR/hr of β+γ				
IV. 70pCi/g of Pu; 65μR/hr of β+γ				
V. 7 pCi/g of Pu; 33μR/hr of β+γ				

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